Tropical Medicine and International Health

VOLUME 7 NO 1 PP 70–79 JANUARY 2002

Evaluation of staff performance and material resources for integrated schistosomiasis control in Northern Senegal

Marieke J. van der Werf[1,2], Amadou Mbaye[3], Seydou Sow[2,3], Bruno Gryseels[2] and Sake J. de Vlas[1]

1 *Department of Public Health, Erasmus University Rotterdam, Rotterdam, The Netherlands*
2 *Prince Leopold Institute of Tropical Medicine, Antwerp, Belgium*
3 *Programme Espoir, St Louis, Sénégal*

Summary

BACKGROUND A project to improve integrated control of schistosomiasis in the primary health care system of Northern Senegal was implemented from February 1995 until September 1999, shortly after a *Schistosoma mansoni* outbreak. The activities included additional training of doctors and nurses in symptom-based treatment and making praziquantel (PZQ) available for an affordable price.
OBJECTIVE To investigate staff performance and the availability and costs of diagnostic materials and PZQ at the end of this intervention project.
METHODS We performed structured interviews with staff from 55 health care facilities in five districts.
RESULTS Respondents from 23 health care facilities reported both *S. haematobium* and *S. mansoni* in the coverage area, 32 reported only *S. haematobium* and three only *S. mansoni*. The average cost to patients for consultation, diagnosis, treatment and transportation to a referral health care facility was approximately 1.60 Euro. Fifty-seven per cent of the health care facilities with reported *S. haematobium* in the coverage area treated patients presenting with haematuria on symptoms; 56% of the health care facilities with reported *S. mansoni* in the coverage area treated patients presenting with blood in stool on symptoms. Thirteen per cent performed a diagnostic test for patients presenting with haematuria and 12% for patients presenting with blood in stool. The remainder, approximately one-third of the health care facilities, referred their patients to another facility for a diagnostic test. Implementation of symptom-based treatment in all health care facilities will reduce the total costs by 0.43 Euro (29%) for patients infected with *S. haematobium* and 0.78 Euro (46%) for patients infected with *S. mansoni*. Of the 53 health care facilities with schistosomiasis in their area, 37 had PZQ in stock of which 33 (88%) sold PZQ for the recommended retail price of 0.15 Euro per tablet (or 0.60 Euro per course of four tablets) or lower.
CONCLUSION Four years after the start of the intervention project, patients presenting with schistosomiasis related symptoms can generally expect proper diagnosis and treatment at all levels of the health care system in Northern Senegal, either at the initial visited health care facility or after referral. However, a further reduction of the total costs of treatment is still possible by a better implementation of symptom-based treatment and further reduction of the costs of PZQ.

keywords schistosomiasis, disease control, primary health care, integration, intervention programme, treatment costs, Senegal

correspondence Marieke J. van der Werf, Department of Public Health, Erasmus University Rotterdam, PO Box 1738, 3000 DR Rotterdam, The Netherlands. Fax: +31-10-408-9449; E-mail: vanderwerf@mgz.fgg.eur.nl

Introduction

The epidemiology of schistosomiasis in Northern Senegal has changed considerably in the past decade. Until 1986, *Schistosoma haematobium* was the only *Schistosoma* species reported in this area (Chaine & Malek 1983; Vercruysse *et al.* 1985). After the construction of two dams, Talla *et al.* (1990, 1992) reported an outbreak of

S. mansoni infection in the district of Richard-Toll, Northern Senegal. The development of a high prevalence and intensity of infection within 3 years combined with frequent occurrence of early disease manifestations (abdominal pain and diarrhoea) (Stelma *et al.* 1993, 1994, 1997; Kongs *et al.* 1996; Picquet *et al.* 1996) called for rapid and adequate control strategies. An increase in the prevalence of *S. haematobium* in the region of St Louis, Northern Senegal was also reported (Verle *et al.* 1994; Picquet *et al.* 1996; Ernould & Ba 1998).

Over the past decades, emphasis in schistosomiasis control has shifted to chemotherapy-based morbidity control (WHO 1993). During the first years after praziquantel (PZQ) became available, this new strategy entailed mainly large-scale chemotherapy campaigns. The initial outcome of these vertical projects was a considerable reduction of infection rates and morbidity. However, the sustainability of these results was often disappointing, due to rapid re-infection and high cost (Gryseels 1989). It became clear that there was a need for long-term strategies to achieve a lasting reduction of infection rates and morbidity. As vertical projects are expensive and difficult to maintain over long periods, WHO has recommended integrating schistosomiasis control in the primary health care structures (WHO 1993). Access to drugs is a key element of a successful control programme. In the WHO medicine strategy this is defined as rational selection and use of drugs, affordable prices, reliable supply systems and sustainable financing. Sustainable financing is assured in Senegal by a cost recovery system based on the Bamako initiative (Diallo *et al.* 1993).

Based on experiences in the country and elsewhere, and according to national policies, the health authorities of Northern Senegal opted for maximum integration of schistosomiasis control in the existing health care structures. The initial strategy was passive case detection and treatment: i.e. patients who reported with intestinal symptoms possibly related to *S. mansoni* infection were prescribed PZQ or oxamniquine (Kongs *et al.* 1994). At the beginning of the epidemic, patients could buy their medication at two private pharmacies for approximately US$ 25. However, these pharmacies often ran out of stock. After 1990, extra control measures were introduced to diminish the prevalence and morbidity caused by schistosomiasis, such as health education of the community and increasing the availability of PZQ in the area, and there were limited attempts to introduce snail control.

In February 1995, the Regional Health Authorities in St Louis started a programme, supported by the European Union, to improve schistosomiasis control in the area by strengthening of primary health care. The project mainly aimed at improving quality and accessibility of symptom-based treatment for schistosomiasis and health education at the community level. PZQ was made available at a reduced price at all levels of the primary health care. Since January 1998, the Regional Health Authorities recommend a retail price of 0.15 Euro per PZQ tablet and a dose of 40 mg/kg bodyweight. However, health committees are free to implement the new price policy. Moreover, health workers were trained in diagnosis and treatment of schistosomiasis patients and equipped with microscopes and haemasticks. Nurses and sanitary agents working in high endemic areas were trained to treat schistosomiasis patients based on symptoms: haematuria for *S. haematobium* and bloody diarrhoea, blood in stool or diarrhoea without fever and/or extreme paleness of the mucous membrane for *S. mansoni*. This strategy was included in the algorithms used by the nurses and sanitary agents. Furthermore, health education materials were prepared and applied with the aim to increase awareness of the symptoms of schistosomiasis and of the transmission cycle. There were four approaches: the development and distribution of educational materials to schoolchildren (in collaboration with the education sector), the production of an educational video film, the development and distribution of posters and billboards and broadcasting of radio programmes. Besides this, there were efforts by other sectors, such as programmes for water supply and the construction of latrines.

In this study, we evaluated the impact of the intervention project on curative health care. We determined the options for treatment and diagnosis and the knowledge of symptoms related to schistosomiasis infection at all levels of the health care system, evaluated the implementation of the price reduction for PZQ, determined the availability of diagnostic materials, counted the number of PZQ tablets available and calculated the total costs of treatment for the patient.

Methods

Study area

The study was conducted in May 1999, in the region of St Louis in Northern Senegal (Figure 1), situated along side the Senegal River. The region is subdivided into five districts: St Louis (217 000 inhabitants), Richard Toll (119 000 inhabitants), Dagana (66 000 inhabitants), Podor (175 000 inhabitants) and Matam (256 000 inhabitants) (estimates for 1999).

Health system

The health services in Northern Senegal are organized according to the primary health care principle (WHO

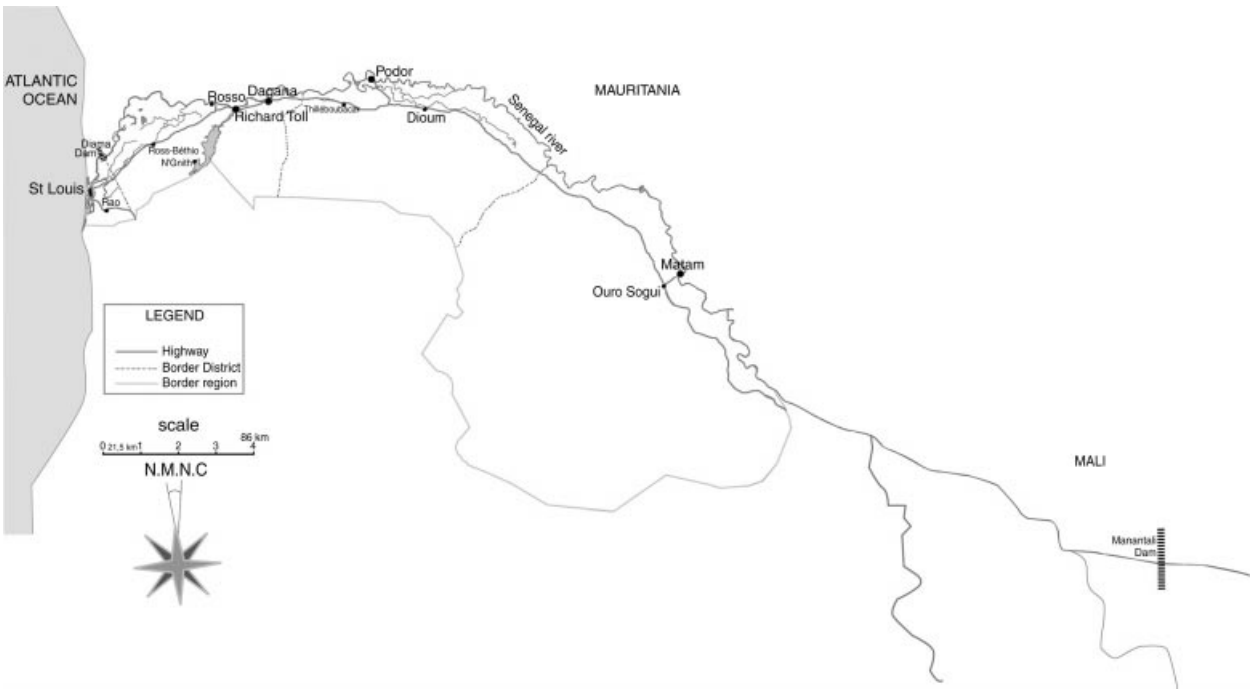

Figure 1 Map of the study area, Northern seregal.

1978), which implies that health care facilities provide primary or secondary health care for a specified population. The number of people formally covered by the health care facility was reported by the person in charge.

Each district contains one health centre and a number of health posts, which varies from 10 to 39 depending on the size of the district. In each health centre there is at least one medical doctor in charge of all activities occurring within the health centre and in the health posts in the same district. The health posts are staffed with nurses or sanitary agents helped by nurse assistants. Their main task is providing simple primary care to their coverage population. Cases which cannot be handled at health posts are referred to the next level, the health centre. These are equipped to give curative and preventive services at primary care level. Complicated cases (including the long-term complications of schistosomiasis) are referred to the hospitals.

St Louis region has three hospitals: the regional hospital in the city of St Louis, a district hospital in Ndioum (Podor) and a district hospital in Ourossogui (Matam). The regional hospital in St Louis employs 12 medical doctors who provide secondary care which includes general medicine, surgery, paediatrics, obstetrics and gynaecology, etc. It functions as the referral hospital for the entire population living in the region of St Louis, 833 000 inhabitants. The district hospital in Podor employs three doctors, the hospital in Matam, two. They provide simple secondary care to the total population of these districts. A health centre normally provides primary health care to the total population living in a district. However, due to the presence of the district hospitals in Podor and Matam, the health centres in these districts only cover the population living nearby. There are four private clinics in the district of St Louis, one in the district of Richard Toll and one in the district of Podor. Other health care facilities in the region of St Louis include Christian charity dispensaries and the health service of the sugarcane factory in Richard Toll. See Appendix for an overview of health care facilities visited.

In 1987, the Senegalese Ministry of Health introduced a cost recovery system for drugs according to the Bamako Initiative (Diallo *et al.* 1993). For Senegal this implied that health care facilities buy generic drugs at the National or Regional Pharmacy. They can make a small profit by selling the drugs to the patients, which enables them to renew their stocks. The retail price of drugs and the type of drugs in stock in the health care facility are determined by the (local) health committee, a group of representatives chosen from the (local) population.

Interviews and data collection

In the hospitals we interviewed the doctor in charge of the general medicine department, in health centres and private clinics the doctor in charge and in health posts the nurse or

sanitary agent in charge. The knowledge of nurses and sanitary agents working in health centres and hospitals was not assessed. Respondents were asked to mention all symptoms they considered to be related to infection with *S. haematobium* or *S. mansoni*. If *S. haematobium* or *S. mansoni* infection was reported not present in the area of responsibility of the health care facility, further questions were not asked. If the infection was reported present, the interview continued with questions about the use of diagnostic tests and the prescription of treatment. The replies given by different professional groups were statistically compared using the Chi-square/Fisher's exact test (SPSS).

After the interview, we collected information on the number of schistosomiasis patients in 1998 and the total number of curative consultations in 1998. The number of PZQ tablets sold in 1998, the number of PZQ tablets currently in stock and the estimated number of days that PZQ was available in 1998 was recorded. At the end of the interview, we asked for the price of the consultation 'ticket', the diagnostic test for schistosomiasis and a PZQ tablet. For all questions we tried to obtain the exact value, if this was not possible an estimated value was asked for.

Cost analysis

We calculated the total costs in Euro for treatment of schistosomiasis for each patient who visited the health care facility in 1998 by adding the price of a consultation ticket, a diagnostic test if requested and treatment with four PZQ tablets (dose for an adult). For health care facilities that reported to refer patients to another facility we took the price of a diagnostic test and PZQ at the centre of reference. The cost of a diagnostic test was considered to be nil in health care facilities that performed symptom-based treatment (i.e. no diagnostic test). If the interviewee referred patients to another health care facility for diagnosis and/or treatment, the estimated costs of transport to the centre of reference were included in the total costs. The costs of transport were provided by the local population. The Senegalese currency (CFA) was converted into Euro (in 1998, 1 Euro was approximately US$ 1 or CFA 650).

Results

The general characteristics of the included health care facilities are presented in Table 1. Only one nurse was not available for the interview (in Podor district). Twenty-three respondents reported the presence of both *S. haematobium* and *S. mansoni* infection in their area of responsibility, 27 reported only *S. haematobium* and three only *S. mansoni*. In only two health care facilities, both infections were reported absent (district St Louis: health post Tassinère and private clinic).

Almost all interviewed persons mentioned the main symptoms of *S. haematobium* (haematuria, 100%) and *S. mansoni* infection (bloody diarrhoea and blood in stool, 94%) (Figure 2). Other symptoms caused by *S. haematobium* infection such as pelvic discomfort and dysuria were mentioned by, respectively, 56% and 33% of respondents. Seven nurses also reported 'other' symptoms normally not related to *S. haematobium*, such as fever and nausea. Seventy-four per cent of the respondents mentioned abdominal discomfort as a symptom related to *S. mansoni* infection. Symptoms related to an advanced stage of the infection such as ascites and haematemesis were rarely mentioned. Four doctors and six nurses mentioned 'other' symptoms that are usually assumed not to be associated with *S. mansoni* infection, such as fever, headache and dizziness.

Comparing the knowledge of the interviewed doctors (working in hospitals, health centres and private clinics) and the interviewed nurses and sanitary agents (exclusively working in health posts) revealed that knowledge was not significantly different except for pollakisuria which was more often mentioned by doctors, 36% *vs.* 2% (Fisher's

Table 1 Characteristics of the health care facilities (HCF) where medical doctors, nurses or sanitary agents were interviewed

Health care facility	No.	Population covered by HCF, median (range)	Number of consultations 1998, median (range)	Number of HCF reporting presence of schistosomiasis in its coverage area (%)	
				S. haematobium	*S. mansoni*
Hospital	3	256 000 (175 000–833 000)	46 000 (15 000–60 000)	3 (100)	1 (33)
Health centre	5	66 000 (9000–217 000)	8800 (1500–17 000)	5 (100)	3 (60)
Health post	44	4100 (500–30 000)	2700 (400–12 000)	40 (91)	21 (48)
Private clinic	3	–*	2300 (2000–2600)	2 (67)	1 (33)
Total	55			50 (91)	26 (47)

*No specified area of responsibility.

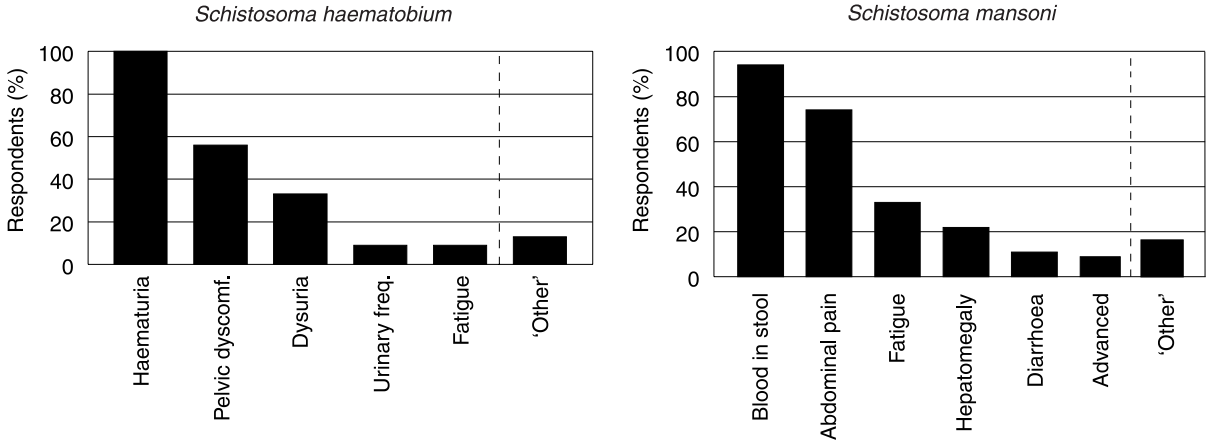

Figure 2 Symptoms mentioned by respondents to be related to *S. haematobium* and *S. mansoni* infection. *S. haematobium*: 'Other' refers to symptoms usually not associated with *S. haematobium*: asthenia, headache, loss of weight, dizziness, vomiting, infertility and pruritis. *S. mansoni*: advanced = symptoms of advanced disease such as oedema, ascitis and haematemesis, 'Other' refers to symptoms usually not associated with *S. mansoni*: fever, *ballonement abdominal* (bloated feeling, flatulence and swollen abdomen) and nausea.

exact $P = 0.004$). The knowledge of symptoms by nurses and sanitary agents did not depend on the reported presence of *S. haematobium* or *S. mansoni* infection in their area of responsibility (not shown).

In 67% of the health posts patients presenting with macroscopic haematuria were treated without parasitological confirmation of the symptom-based diagnosis (Table 2). Twenty-two (85%) of these health posts had PZQ available. Only one health centre performed symptom-based treatment, and PZQ was available. For patients presenting with other symptoms related to *S. haematobium* infection both in health posts and in hospitals and health centres a diagnostic confirmation was always considered necessary.

Symptom-based treatment for *S. mansoni* infection (for blood in stool/bloody diarrhoea) was performed in 13 (62%) of the health posts and in one (25%) health centre in endemic areas (Table 2). PZQ was available in eight (62%) of these health posts and in also in the health centre. In Northern Senegal, all three hospitals had a laboratory; three of five health centres and six of 44 health posts had at least one microscope (Table 3). Other equipment necessary for a parasitological diagnosis of *S. haematobium* (urine filtration test: filters, syringes, tubes and glass-slides, urine centrifugation test: tubes, glass-slides and centrifuge) or *S. mansoni* (Kato–Katz method: mesh, template, cellophane/polyethylene coverslips, glycerine, malachite green and glass-slides, direct faecal smear: glass-slides) was available at health care facilities that reported to perform a parasitological diagnostic test. For parasitological diagnosis of *S. haematobium* infection, most laboratories performed the urine centrifugation test, sometimes in combination with the urine filtration test. In the districts of Podor and Matam where most *S. haematobium* cases are found (Chaine & Malek 1983; Picquet *et al.* 1996) more than 50% of the health care facilities were able to perform a diagnostic test (parasitological or haemastick) at the health care facility level.

Table 2 Diagnosis and treatment strategy for patients reporting with haematuria or blood in stool and bloody diarrhoea in hospitals, health centres and health posts in areas endemic for *S. haematobium* and *S. mansoni*

	Hospitals and health centres	Health posts
Haematuria		
Direct treatment with praziquantel	1 (12)	26 (67)
Diagnosis by haemastick	0 (0)	1 (3)
Diagnosis by urine filtration or centrifugation	5 (63)	0 (0)
Referral for diagnostic test	2 (25)	12 (30)
Total	8 (100)	39 (100)
Blood in stool and bloody diarrhoea		
Direct treatment with praziquantel	1 (25)	13 (62)
Diagnosis by direct smear or Kato–Katz	2 (50)	1 (5)
Referral for diagnostic test	1 (25)	7 (33)
Total	4 (100)	21 (100)

Values in parentheses are in percentages.

Parasitological confirmation of *S. mansoni* infection was most often carried out with the direct faecal smear

Table 3 Availability of laboratory and/or microscope, diagnostic materials and praziquantel in hospitals, health centres and health posts in Northern Senegal

Available	Hospitals and health centres ($n = 8$)	Health posts ($n = 44$)
Laboratory and/or microscope	6 (75)	6 (14)
Material for parasitological diagnostic test *S. haematobium**	6 (75)	1 (2)
Material for parasitological diagnostic test *S. mansoni*†	3 (38)	6 (14)
Praziquantel	6 (75)	33 (75)

Values in parentheses are in percentages.
* Filters, syringes, tubes and glass-slides (urine filtration test) or tubes, glass-slides and centrifuge (urine centrifugation test).
† Mesh, template, cellophane/polyethylene coverslips, glycerine, malachite green and glass-slides (Kato–Katz method) or glass-slides (direct fecal smear).

technique. More than 50% of the laboratory personnel reported to use the Kato–Katz technique if the direct faecal smear technique was negative. If a diagnostic test was considered necessary and the facility did not have a laboratory or microscope, patients were referred to another health care facility. Doctors working in a private clinic always referred to a health centre or hospital for a diagnostic test. Reasons reported for not referring for a diagnostic test were high costs of a diagnostic test and the long journey to the nearest laboratory.

PZQ (600 mg) was the only drug used in the programme in Northern Senegal for the treatment of *S. haematobium* and *S. mansoni* infection. The recommended dose of 40 mg/kg was prescribed by 75% of the hospitals and health centres and by 85% of the health posts. The other health care facilities prescribed 30 or 45 mg/kg body-weight, and 10% of nurses and sanitary agents did not know the recommended dose.

Seventy-five per cent of the hospitals, health centres and health posts had PZQ in stock at the time of the interview (Table 3). One hospital, one health centre and eight health posts with less than 25 schistosomiasis cases in 1998 did not have any because they always referred schistosomiasis patients to other health care facilities for treatment. More than 60% of the health care facilities with PZQ had >100 tablets in stock. Hospitals and health centres had PZQ every day in 1998. Of 34 health posts with PZQ available in 1998, 59% had it throughout the year. The duration of the periods that PZQ was reported unavailable in 1998 ranged from a few to 330 days (median 40 days).

Table 4 Prices of consultation tickets, diagnostic tests and treatment in hospitals/health centres and health posts in Euro*

	Hospitals and health centres		Health posts		All	
	Real mean costs	Mean including zeros	Real mean costs	Mean including zeros	Real mean costs	Mean including zeros
S. haematobium area						
Consultation ticket adult	0.45	0.45	0.17	0.17	0.22	0.22
Four praziquantel tablets	0.92	0.92	0.80	0.80	0.82	0.82
Diagnostics	1.11	1.11	0.48	0.22	0.66	0.35
Transportation to other HCF	0.73	0.17	0.77	0.07	0.74	0.08
Total costs		2.65		1.27		1.48
S. mansoni area						
Consultation ticket adult	0.22	0.22	0.24	0.24	0.27	0.27
Four praziquantel tablets	0.82	0.82	0.64	0.64	0.63	0.63
Diagnostics	0.73	0.73	0.64	0.47	0.68	0.57
Transportation to other HCF	0.00	0.00	0.76	0.34	0.76	0.21
Total costs		1.66		1.69		1.68

* The mean price is a weighted average of the number of schistosomiasis patients visiting each health care facility in 1998. For facilities that neither performed diagnostic tests nor referred patients for one, the costs of a diagnostic test was taken at 0 Euro. See Appendix for costs per health care facility.

The mean price of a consultation ticket for adults in areas where *S. haematobium* infection is reported to be endemic was 0.22 Euro and in areas where *S. mansoni* infection is reported to be endemic 0.27 Euro (Table 4). The mean price of a test to diagnose *S. haematobium* eggs or haematuria, weighted for the number of patients and excluding the patients for which no diagnostic test was performed, was 0.66 Euro. The price of a urine centrifugation or filtration test ranged from 0.46 to 3.08 Euro, the haemastick test was less expensive, reported prices ranged from 0.00 to 0.31 Euro. The mean price of a diagnostic test for *S. mansoni* infection was 0.68 Euro. The minimum price was 0.46, the maximum, 1.54 Euro. Eighty-eight per cent of health care facilities sold PZQ for the recommended price of 0.15 Euro. The maximum price for one PZQ tablet was 0.46 Euro in the district hospital of Matam. The mean price of four PZQ tablets in *S. haematobium* and *S. mansoni* endemic areas was comparable.

Patients that were referred to another health care facility for a diagnostic test or for PZQ had to spend on average 0.75 Euro for transport. Most were referred for a diagnostic test for *S. mansoni* (1666 patients in 1998). Less than 10% of the individuals with *S. haematobium* infection had to travel to another health care facility. The total costs (consultation ticket, diagnostic test, PZQ and transport to other health care facility) to patients infected with *S. haematobium* were on average 1.48 Euro (range 0.77–5.47). For patients infected with *S. mansoni* the average total costs were 1.68 Euro (range 0.77–3.94).

Discussion

Since 1993, the World Health Organization has recommended a policy which aims at reducing the morbidity caused by *S. haematobium* and *S. mansoni* infection in highly endemic areas by integrating control in primary health care systems (WHO 1993). This policy was also the main aim of the intervention project in the highly endemic area in Northern Senegal. The adequate knowledge of doctors, nurses and sanitary agents, the implementation of symptom-based treatment strategies (especially at health post level) and the wide availability of PZQ at a relatively low price are the main results of the intervention programme. However, these results have been obtained by considerable investment of supervision time and capital. Whether they are sustainable remains to be seen.

Symptom-based treatment depends on sufficient knowledge of the main symptoms of schistosomiasis. In our study population, knowledge of the main symptoms of *S. haematobium* (haematuria) and *S. mansoni* infection (bloody diarrhoea/blood in stool) was satisfactory at all levels of the primary health care. However, despite the newly introduced policy to treat patients based on symptoms, more than half of the respondents still considered a laboratory test necessary. As more than half of the health posts did not have the laboratory equipment necessary for the parasitological diagnosis of schistosomiasis, a high percentage of patients had to be referred to another health care facility for a diagnostic test.

Symptoms related to an advanced stage of *S. mansoni* infection are rarely reported. So far only a small percentage of the population shows abnormalities on ultrasound investigation (Kardorff *et al.* 1996; Kongs *et al.* 1996; Yazdanpanah *et al.* 1997; Burchard *et al.* 1998). This might explain the underreporting of symptoms related to advanced disease by doctors, nurses and sanitary agents. As PZQ treatment can partially reverse the pathology of advanced disease (Boisier *et al.* 1998; Frenzel *et al.* 1999), rapid detection and treatment of these cases by improved knowledge of doctors, nurses and sanitary agents on these symptoms is important.

The first aim of the intervention project, lowering the price of PZQ and increasing availability, appeared to have been widely realized. PZQ was widely available in the health care facilities 4 years after the start of the intervention programme. None of the health centres and hospitals had run out of stock and had a constant large supply in 1998. At health posts PZQ was available most of the time. Health committees decide what drugs should be available at their health care facility. Hence this may be an indication that schistosomiasis is considered a priority by the committees. The special attention focused on schistosomiasis in the area probably also influenced the decisions of the health committee. Another explanation for the high availability of PZQ might be that during the intervention project it was sometimes distributed for free, making it available to those facilities that would not normally stock it because they only diagnose a few schistosomiasis patients per year.

Part of the aim of the intervention project was to change the retail price by reducing the wholesale price of PZQ. The National/Regional pharmacy made PZQ available at a price of 0.13 Euro per tablet and the Regional Health Authorities recommended a retail price of 0.15 Euro. Therefore, health care facilities can still make a small profit, which enables them to replenish their stocks. Most health care facilities that participated in our study had introduced the new low retail selling price. A few health care facilities nevertheless sold PZQ at a higher price, reportedly because they needed to cover the costs for transport of the drug. The relatively low retail selling price of PZQ could have a strong positive influence on the access to treatment. However, although the recommended price of 0.15 Euro for one tablet is low compared with

prices in other countries (Renganathan & Cioli 1998), it still comprises almost half of the total costs of the treatment, which remains relatively high for a part of the (rural) population.

Implementation of all interventions according to the project will further reduce the total costs, especially symptom-based treatment. This eliminates the costs of diagnostic tests and the costs of (local) transport to another clinic, resulting in potential savings of 0.43 Euro (29%) for patients infected with *S. haematobium* (0.35 + 0.08 Euro) and 0.78 Euro (46%) for patients infected with *S. mansoni* (0.57 + 0.21 Euro) (Table 4). Applying the reduced retail price of PZQ in all health care facilities will lower the costs of treatment only by 0.22 Euro (mean price 0.60 instead of 0.82) for *S. haematobium* patients and by 0.03 Euro (0.60 rather than 0.63) for *S. mansoni* patients. To make the health system more accessible for schistosomiasis patients, the Regional Health Authorities should stress the importance of symptom-based treatment.

Ideally, evaluation of a project compares pre- and post-intervention data. In Northern Senegal, pre-intervention data were unfortunately not systematically collected. Thus we could only assess the situation at the end of the intervention project, and conclude that 4 years after the start of the programme the primary health care system is able to provide adequate and affordable diagnosis and treatment for the majority of patients reporting with schistosomiasis-related symptoms. It would be interesting to evaluate the sustainability of this intervention after some more years by using the same quantitative method.

Acknowledgements

We gratefully acknowledge the help of M. Wade, Dr P. Faye, Dr M. Diop, Dr M. Traoré, Dr C. Hanne, Dr C. Seck, the primary health care supervisors of the health centres, Dr A. Ly from the *Région Médicale de St Louis* and all nurses and sanitary agents who participated in the study. We also thank Dr A.A. Wyffels, Dr F. Moerman and Prof. Dr J.D.F. Habbema for critical comments. This study was conducted as part of the NWO/WOTRO funded multidisciplinary programme 'Model-based decision support for schistosomiasis control in Ghana, Mali, Niger and Senegal'.

References

Boisier P, Ramarokoto CE, Ravaoalimalala VE *et al.* (1998) Reversibility of *Schistosoma mansoni*-associated morbidity after yearly mass praziquantel therapy: ultrasonographic assessment. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **92**, 451–453.

Burchard GD, Guisse-Sow F, Diop M *et al.* (1998) *Schistosoma mansoni* infection in a recently exposed community in Senegal: lack of correlation between liver morphology in ultrasound and connective tissue metabolites in serum. *Tropical Medicine and International Health* **3**, 234–241.

Chaine JP & Malek EA (1983) Urinary schistosomiasis in the Sahelian region of the Senegal River Basin. *Tropical and Geographical Medicine* **35**, 249–256.

Diallo I, Molouba R & Sarr LC (1993) Primary health care: from aspiration to achievement. *World Health Forum* **14**, 349–355.

Ernould J-C & Ba K (1998) Epidemiologie des bilharzioses humaines. In: *Amenagements Hydro-argicoles et sante*. Orstom, Paris, pp. 263–282.

Frenzel K, Grigull L, Odongo-Aginya E *et al.* (1999) Evidence for a long-term effect of a single dose of praziquantel on *Schistosoma mansoni*-induced hepatosplenic lesions in Northern Uganda. *American Journal of Tropical Medicine and Hygiene* **60**, 927–931.

Gryseels B (1989) The relevance of schistosomiasis for public health. *Tropical Medicine and Parasitology* **40**, 134–142.

Kardorff R, Stelma FF, Vocke AK *et al.* (1996) Ultrasonography in a Senegalese community recently exposed to *Schistosoma mansoni* infection. *American Journal of Tropical Medicine and Hygiene* **54**, 586–590.

Kongs A, Verle P & Talla I (1994) Epidemic schistosomiasis in the delta of the Senegal River Basin, Senegal: responses of the health care system. *Annales de la Société Belge de Médecine Tropicale* **74**, 301–315.

Kongs A, Verle P, Dieng A, Talla I & Rouquet P (1996) Clinical investigation of a population recently infected with *Schistosoma mansoni* (Richard-Toll, Senegal). *Tropical Medicine and International Health* **1**, 191–198.

Picquet M, Ernould JC, Vercruysse J *et al.* (1996) Royal Society of Tropical Medicine and Hygiene meeting at Manson House, London, 18 May, 1995. The epidemiology of human schistosomiasis in the Senegal river basin [see comments]. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **90**, 340–346.

Renganathan E & Cioli D (1998) An international initiative on praziquantel use. *Parasitology Today* **14**, 390–391.

Stelma FF, Talla I, Polman K *et al.* (1993) Epidemiology of *Schistosoma mansoni* infection in a recently exposed community in northern Senegal. *American Journal of Tropical Medicine and Hygiene* **49**, 701–706.

Stelma FF, Talla I, Verle P, Niang M & Gryseels B (1994) Morbidity due to heavy *Schistosoma mansoni* infections in a recently established focus in northern Senegal. *American Journal of Tropical Medicine and Hygiene* **50**, 575–579.

Stelma FF, v.d. Werf M, Talla I, Niang M & Gryseels B (1997) Four years' follow-up of hepatosplenic morbidity in a recently emerged focus of *Schistosoma mansoni* in northern Senegal. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **91**, 29–30.

Talla I, Kongs A & Verle P (1992) Preliminary study of the prevalence of human schistosomiasis in Richard-Toll (the Senegal river basin). *Transactions of the Royal Society of Tropical Medicine and Hygiene* **86**, 182.

Talla I, Kongs A, Verle P, Belot J, Sarr S & Coll AM (1990) Outbreak of intestinal schistosomiasis in the Senegal River Basin. *Annales de la Société de Belge de Médecine Tropicale* **70**, 173–180.

Vercruysse J, Southgate VR & Rollinson D (1985) The epidemiology of human and animal schistosomiasis in the Senegal River Basin. *Acta Tropica* **42**, 249–259.

Verle P, Stelma F, Desreumaux P *et al.* (1994) Preliminary study of urinary schistosomiasis in a village in the delta of the Senegal river basin, Senegal. *Transactions of the Royal Society of Tropical Medicine and Hygiene* **88**, 401–405.

World Health Organization (1978) *Report on the International Conference on Primary Health Care.* Alma Ata, USSR, 6–12 September. Declaration of Alma-Ata. WHO, Geneva.

World Health Organization (1993) *The Control of Schistosomiasis.* Technical Report Series No. 830. World Health Organization, Geneva.

Yazdanpanah Y, Thomas AK, Kardorff R *et al.* (1997) Organometric investigations of the spleen and liver by ultrasound in *Schistosoma mansoni* endemic and nonendemic villages in Senegal. *American Journal of Tropical Medicine and Hygiene* **57**, 245–249.

Appendix Referral scheme and costs (Euro) for *S. haematobium* and *S. mansoni* diagnosis and treatment

Health care facility	Costs of consultation ticket	Costs PZQ for adult*†	*S. haematobium* Number of patients‡	*S. haematobium* Costs of test†	*S. haematobium* Total costs for adult§	*S. mansoni* Number of patients‡	*S. mansoni* Costs of test†	*S. mansoni* Total costs for adult§
St Louis								
1 Hospital St Louis	1.54	*(6)*	15	3.07	5.47	~	1.54	3.94
2 HC St Louis	0.46	*(6)*	25	*(1)*	4.39	5	*(1)*	2.86
3 HP Goxu Moth	0.15	*(6)*	**2**	*(1)*	4.08	–	–	–
4 HP Guett Ndar	0.15	*(6)*	5	*(1)*	4.08	12	*(1)*	2.55
5 HP Mbakhana	0.15	0.62	50	*(1)*	3.84	–	–	–
6 HP Poste Sud	0.15	0.86	**5**	*(1)*	4.08	–	–	–
7 HP Tassinere	0.15	–	–	–	–	–	–	–
8 PC St Louis	6.15	–	–	–	–	–	–	–
Richard-Toll								
9 HC Richard-Toll	0.31	0.62	**67**	0.77	1.70	**2067**	0.77	1.70
10 HP Boundoum Barage	0.31	0.62	**10**	¶	0.93	**8**	*(9)*	1.70
11 HP Diawar	0.31	0.62	**9**	*(9)*	1.70	**236**	*(9)*	1.70
12 HP Gallo Malick	0.31	0.62	**8**	*(9)*	1.70	**816**	*(9)*	1.70
13 HP Nbagam	0.31	0.62	16	*(9)*	1.70	200	¶	0.93
14 HP Ndiangue	0.31	0.62	–	–	–	**35**	*(9)*	1.70
15 HP Niassene	0.15	*(18)*	10	¶	0.77	5	¶	0.77
16 HP Ronkh	0.31	0.77	–	–	–	**468**	*(9)*	1.85
17 HP Rosso Senegal	0.31	0.62	**8**	*(9)*	1.70	**258**	¶	0.93
18 HP Savoigne	0.31	0.62	**162**	0.46	1.39	**179**	0.46	1.39
19 HP Taouey	0.31	0.62	~	*(9)*	1.70	~	*(9)*	1.70
20 PC Richard-Toll	4.62	*(9)*	2	*(9)*	6.01	~	*(9)*	6.01
Dagana								
21 HC Dagana	0.31	0.62	**58**	0.77	1.70	**188**	0.31	1.24
22 HP Bokhol	0.15	0.62	**211**	¶	0.77	**239**	¶	0.77
23 HP Dagana cite	0.15	0.62	**25**	*(21)*	1.54	**84**	*(21)*	1.08
24 HP Diagle	0.15	0.62	–	–	–	**174**	0.46	1.23
25 HP Gaya	0.15	0.62	**106**	0.08	0.85	**127**	0.46	1.23
26 HP Guidakhar	0.15	0.62	**7**	*(9)*	1.54	**166**	¶	0.77
27 HP Mbane	0.15	0.62	**4**	¶	0.77	**235**	0.46	1.23
28 HP Mbilor	0.15	0.62	**7**	*(21)*	1.54	**129**	¶	0.77
29 HP Ndombo Diop	0.15	0.62	**6**	*(9)*	1.54	**166**	0.46	1.23
30 HP Niassante	0.15	0.62	**12**	*(21)*	1.54	–	–	–
31 HP Thiago	0.15	0.62	**11**	*(9)*	1.54	**175**	0.46	1.23

Appendix (*Continued*)

Health care facility	Costs of consultation ticket	Costs PZQ for adult*†	*S. haematobium*			*S. mansoni*		
			Number of patients‡	Costs of test†	Total costs for adult§	Number of patients‡	Costs of test†	Total costs for adult§
Podor								
32 Hospital Ndioum	0.46	0.62	50	1.54	2.62	–	–	–
33 HC Podor	0.31	0.62	~	0.46	1.38	–	–	–
34 HP Cascas	0.15	0.62	**53**	0	0.77	–	–	–
35 HP Dara Haleybe	0.15	0.62	**140**	0 *(32)*	0.77	–	–	–
36 HP Dounguel	0.15	*(32)*	5	*(32)*	2.31	**2**	*(32)*	~
37 HP Gollere	0.15	0.62	**6**	*(32)*	2.31	–	–	–
38 HP Mboumba	0.15	0.62	**30**	~	~	–	–	–
39 HP Mboyo	0.23	0.77	**115**	0	1.00	–	–	–
40 HP Ndiawara	0.15	0.62	**165**	0 *(33)*	0.77	–	–	–
41 HP Ndiayene Pendao	0.15	0.62	**18**	*(32)*	2.31	–	–	–
42 HP Walalde	0.15	**	~	**	~	–	–	–
43 PC Podor	0.31	*(33)*	250	*(33)*	1.39	–	–	–
Matam								
44 Hospital Ourossogui	0.77	1.85	85	0.77	3.39	–	–	–
45 HC Matam	0.15	0.62	**85**	*(44)*	1.54	–	–	–
46 HP Agnam Civol	0.15	0.62	**5**	0.31	1.08	–	–	–
47 HP Dembankane	0.15	1.23	240	¶	1.38	–	–	–
48 HP Gaol	0.15	0.62	20	¶	0.77	–	–	–
49 HP Goumal	0.31	0.62	**77**	0.15	1.08	–	–	–
50 HP Mil. Ourossogui	0	*(44)*	**23**	*(44)*	2.62	–	–	–
51 HP N'dendory	0.15	0.62	**186**	0	0.77	–	–	–
52 HP Ndiaffane	0.15	0.62	**9**	0.08	0.85	–	–	–
53 HP Ndouloumadji	0.15	0.62	**3**	0	0.77	–	–	–
54 HP Sinthiou Bamambe	0.15	1.23	400	0.15	1.53	–	–	–
55 HP Sinthiou Garba	0.15	0.62	30	0.04	0.81	–	–	–

*Costs of 4 PZQ tablets, dose for adult.
† (*Number of the health care facility referred to*).
‡ Number of patients diagnosed by the health care facility in 1998 (bold: exact numbers; normal: estimated numbers).
§ Costs of consultation ticket + costs of diagnosis (if performed) + costs of PZQ for adult + costs of transport if the patient is referred.
¶ Direct treatment.
** Unknown to which health post referred.
(–) Not applicable, no *S. haematobium* or *S. mansoni* in area; (~) missing value.